DOCUMENT RESUME

ED 351 359 TM 019 169

AUTHOR Blumberg, Carol Joyce
TITLE A Study of Salary Equity at a Teaching-Oriented Undergraduate Institution Using Multiple Models.
PUB DATE Apr 92
NOTE 22p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, CA, April 20-24, 1992).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *College Faculty; Employment Practices; Equal Opportunities (Jobs); Females; Higher Education; Males; Predictor Variables; Reference Groups; *Regression (Statistics); Research Methodology; Salaries; *Salary Wage Differentials; Sex Differences; *Sex Discrimination
IDENTIFIERS *Winona State University MN

ABSTRACT

A recent study of salary equity at an undergraduate institution using traditional regression-based methodology is presented. In a traditional salary equity study a linear model is empirically fitted for predicting salaries (the dependent variable) from a set of independent (predictor) variables using the most up-to-date data possible for some base group, usually Caucasian males. The base group model is then applied to all eligible faculty members to predict salaries that they would have earned under the model. The differences between actual and predicted salaries are measures of pay inequity. Data for this study came from the 1989-90 fiscal year for Winona (Minnesota) State University. When the regression equation based on male faculty data (n=176) without rank as a predictor, was applied to the female faculty data, it was found that, on the average, female faculty members (n=78) were underpaid by $3,113 when compared to male faculty. Predictor variables and departmental differences are discussed in detail. Five tables present study data. (SLD)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

CAROL JOYCE BLUMBERG

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

ED351359

A Study of Salary Equity at a Teaching-Oriented Undergraduate Institution Using Multiple Models

Carol Joyce Blumberg
Department of Mathematics and Statistics
Winona State University
Winona, MN 55987-5838

Presented as a part of the Symposium entitled Methodological Issues and Concerns for Gender-Equity Studies, American Educational Research Association Annual Meeting, April 20, 1992, San Francisco, CA.

TM019169

BEST COPY AVAILABLE

A Study of Salary Equity at a Teaching-Oriented Undergraduate Institution Using Multiple Models

Background

In April, 1990 the author of this study was asked by the faculty association's Women's Issues Committee and the Academic Vice President of Academic Affairs of Winona State University (to be abbreviated WSU for the remainder of this paper) to conduct a study of salary inequity among the WSU faculty. In two meetings held jointly with the Women's Issues Committee and Academic Vice President it was decided to follow the methodology that has been traditionally used in studies of salary equity on various campuses. The methodology used was based heavily on stepwise linear regression and various regression diagnostics. It is assumed in this paper that the reader is familiar with multiple linear regression, but may not be familiar with stepwise linear regression and/or regression diagnostics.

This paper is one of four papers being presented in a symposium entitled "Methodological Issues and Concerns for Gender-Equity Studies". Its main purpose is to present a recent study of salary equity done using the traditional regression-based methodology. Its secondary purpose is to briefly discuss a few methodological issues that arose while doing the study. The other papers in this symposium provide critiques of this methodology and/or alternative methods for performing salary equity studies.

Traditional Methodology

The traditional methodology used in salary equity studies is described in full detail in Scott (1977). Those who decide to do a salary equity based on this methodology should also read Gray (1990) which provides answers to some of the issues not addressed in the original Scott (1977) booklet.

In a traditional salary equity study a linear model is empirically fitted (that is, derived) for predicting salaries (the dependent variable) from a set of independent (predictor) variables using the most up-to-date data possible for some base group. This base group model is then applied to all eligible faculty members to predict the salaries they would have earned under that model. The differences between each person's actual salary and predicted salary (called residuals) are measures of pay inequity. The base group is usually Caucasian males. In this study, Caucasian males were initially used as the base group. But, for reasons that will be explained later in this paper, the base group used in the final analyses in WSU's salary equity study was all males in tenured or tenure-track positions.

The independent variables to be used will vary slightly from institution to institution, due to differences in set-up and criteria for hiring, promotion, and tenure. One must, however, be very careful not to pick independent variables which are influenced by decisions made at various levels in the institution, rather than being intrinsic to the individuals under consideration. For example, the number of years a faculty member

spends as an Associate Professor is highly influenced by decisions of various committees and administrators. Thus, if females are not promoted as quickly as males from Associate Professor to Full Professor, because of discrimination or other reasons, then using rank as one of the independent variables may cause the salaries predicted for the female faculty members from the derived model based on Caucasian male faculty to be lower than they should be. The reason for this is that some females will be at lower ranks than males equivalent to them in all other ways. Hence, their predicted salaries are shifted downwards to reflect their lower rank.

Once data are collected on the relevant independent variables and on the dependent variable of salary, the base group is then separated out from the rest of the faculty. Stepwise linear regression is then performed using the data from the base group to determine which independent variables contribute significantly (both meaningful significance and statistical significance are important in these studies) to predicting the salaries of the base group. Nominal (categorical) level variables can, and often should be, used as possible independent variables. There are several variants of stepwise regression.

The first variant is backward elimination stepwise regression that starts with all of the independent variables being used in the prediction equation. It then deletes independent variables one at a time by looking at which variable can be deleted at each stage because it is least important

according to some statistical criterion. Often this criterion is that the variable that least reduces the multiple R^2 is deleted. Variables continue to be deleted until there is a statistically significant change according to the statistical criterion being used.

The second variant is forward stepwise regression. Forward stepwise regression starts with a simple linear regression equation using the independent variable (out of all the possible independent variables) that has the highest R^2 with the dependent variable. Variables are then entered one at a time until a statistically significant change in the statistical criterion being used does not occur. Here, as with backward elimination, the statistical criterion often used is the multiple R^2. The discussion of the various criteria used, in addition to multiple R^2, is beyond the scope of this paper.

The third variant is most often referred to simply as stepwise regression. It works exactly like forward stepwise regression, except that at each stage the independent variables that have already been entered are checked to see if any can be deleted. The criteria for deletion are beyond the scope of this paper.

Once the "best" set of independent variables and their corresponding regression equation are determined for predicting the salaries of the base group, this regression equation is then applied to all faculty to obtain each faculty member's predicted salary. A residual is then calculated for each faculty member by

subtracting the actual salary from the predicted salary. The residuals are then analyzed, using methods that will be discussed later in this paper.

Data Collection for the Winona State Study

After several meetings with the Women's Issue Committee and the Vice President of Academic Affairs it was decided to include the following for use as possible independent variables:

a. Highest degree earned

b. Is that degree a terminal degree according to the union contract? For some fields, the faculty association has negotiated that certain non-doctoral degrees will be considered as terminal. For example, the MFA (Master of Fine Arts) is considered as terminal for those faculty in Art (except for Art History and Art Education).

c. Age. Age was used as a proxy for years of relevant experience prior to being hired in one's present position at WSU. According to Scott (1977), years of relevant experience is almost impossible to calculate. Age is logically (and empirically) highly correlated with years of relevant experience. Hence, Scott recommends using Age in the place of years of relevant experience. As a side note, one morning the Director of Human Resources and the author spent approximately two hours looking at a sample of faculty and trying to determine their years of relevant experience. Some of the questions that quickly arose were: (i) Should years of experience in the business world count

for everyone, just for faculty in the College of Business, or for no one? (ii) Is military experience relevant? (iii) How should high school teaching experience be counted? (iv) How should experience as a teaching and/or research assistant as a graduate student be counted? After these two hours, Dr. Scott's point about using Age instead of years of relevant experience became crystal clear.

d. Years of experience in the Minnesota State University System (of which WSU is a member) in their present position. This was used instead of years of experience at WSU, since when a faculty member at one Minnesota State University System institution decides to take a position at another Minnesota State University System institution, they are allowed the choice of transferring their rank, salary and years of experience or renegotiating their rank and/or salary and having their years of experience in the Minnesota State University System set back to zero.

e. Is the person eligible for a market factor? Some faculty members with doctorates in certain fields are eligible for an extra payment each year over that salary they get according to the union contract. This variable simply tells whether a faculty member is eligible or not. The amount of the extra payment will be dealt with in the section on how salaries were determined for this particular study.

f. Type of position. There are four types of faculty positions: Fixed Term (temporary), Non-Tenure Track (permanent

positions that are renewed annually but which do not carry the possibility of tenure), Probationary (faculty members who are in tenure-track positions and have not yet gained tenure) and Tenured.

g. College. A coding was used to indicate in which College (Business, Education, Liberal Arts, Nursing, or Science & Engineering) a faculty member had their main appointment. The reason that College was used instead of Department (as would be the case for many larger institutions) is that only two departments out of 32 departments on campus had 10 or more males in them. Further, at WSU the Deans of the Colleges are the lowest level of administrators that make decisions that affect salaries (Department Chairs are considered to be regular faculty members who act more like team leaders rather than administrators). There were also faculty members, such as librarians and student affairs personnel, who are not members of one of the five Colleges. These faculty members were combined together into a category called Other. For analysis purposes the faculty members for the College of Nursing and the College of Science & Engineering were combined since there were only two male faculty members in the College of Nursing. The reason for combining Nursing with the College of Science and Engineering (rather than with some other College) was that in many respects the salaries of faculty members in Nursing are comparable to those in many departments in the College of Science and Engineering.

The dependent variable was, of course, Salary. There were, however, some decisions that had to be made with respect to salary. For example, it was decided that since Department Chair is a temporary position, the salaries for Department Chairs would be the salary without the Chair's supplement. Also, those on sabbatical or other types of leave had to have their salaries readjusted for the purposes of this study to what they would have been if the faculty member had not been on leave. It was further decided to try two different ways of figuring salary and to construct regression equations using each of these ways:

a. Contract salary with no overload or summer supplemental pay included.

b. Contract salary with no overload or summer supplemental pay included, but with market factor bonuses added for those faculty who earned them. All faculty who are eligible for market factor bonuses are not necessarily given a market factor bonus nor are all those given market factor bonuses given the same amount. The market factor bonus given each eligible faculty member is determined by the appropriate Dean.

The data analyzed in this study were from the 1989-90 fiscal year. This may seem odd for a study whose results are being reported in 1992, but the author had to get approval from several sources (Vice President of Academic Affairs, Women's Issues Committee, and Faculty Senate) at every step in the study. With so many approvals needed at each step, it took almost 17 months to complete the data analyses reported in this paper.

Preliminary Data Analysis

The first step was to run a series of regression analyses using all full-time Caucasian male faculty as the base group to determine whether the dependent variable of salary should include the market factor bonus and which independent variables best predicted these salaries. The equations derived from the Caucasian males were then applied to the non-Caucasian males, Caucasian females, and non-Caucasian females. Although the differences were not dramatic, the inclusion of market factor bonuses as part of salary did give better predictions for Caucasian males. Hence, all further analyses used salary with market factor bonus included as the dependent variable.

At this point, an interesting situation was encountered. For all groups, those faculty members determined to have salary inequities were over-proportionately those in non-tenure track or fixed term positions. This is not all that surprising, since at WSU, as is true in general across the country, people in these types of positions were, with a few exceptions, hired at the minimum salary possible. Hence, the decision was made by the Women's Issue Committee and the Vice President of Academic Affairs to restrict the remainder of the salary equity study to only probationary (i.e., tenure-track) and tenured faculty members. Table 1 presents a breakdown of the number of male and female faculty holding each type of position and the percentage of faculty in each type of position who were found to have a

standardized residual of -1.0 or below under the preliminary model.

A standardized residual is defined for the purpose of salary equity studies as a person's residual (actual salary minus predicted salary) divided by the standard deviation of the residuals of the base group. A standardized residual of -1.0 will occur approximately 16% of the time in the base group if the salaries are approximately normally distributed.

INSERT TABLE 1 HERE

It was also decided to ignore ethnicity in future data analyses, since these preliminary analyses seem to indicate that ethnicity was not a factor in salary inequities at WSU. All of the graphs and scatter plots created of the residuals for Caucasian and non-Caucasian males were extremely similar as were the graphs and scatter plots of the residuals for Caucasian and non-Caucasian females.

Results of the Final Regression Analyses Performed Using Probationary and Tenured Males Only

From the time of the initial meeting that began the equity study, the question remained as to whether Rank should or should not be used as a predictor (independent variable) in the regression equations. Scott (1977) makes the point that Rank should not be used as a predictor since it is highly influenced

by administrative decisions and many times is biased against females. Yet, some of the studies examined used Rank as one of the predictor variables. Hence, it was decided to build two models, one that included Rank as one of the independent variables and one that did not, in order to investigate whether Rank should be used a predictor for the WSU study. At the time this was decided upon (early in 1991), the author had not yet received a copy of Gray (1990). Gray recommends that institutions run analyses both with and without Rank as a predictor, although models including Rank as a predictor will tend to underestimate inequities.

For building both models, all three variants of stepwise regression were tried. This is often the case in studies using stepwise regression. For each model, it turned out that all three variants yielded the same set of independent variables as the predictors. Hence, in the remainder of this paper all analyses will be discussed only in terms of forward stepwise regression.

These analyses, as well as all remaining analyses involving male faculty, were based on the data from the 176 probationary or tenured male faculty. There were several criteria for determining the best set of predictor variables in this study. The principal criterion used was R^2. Although there is some disagreement among statisticians as to when R^2 should or should not be adjusted for the number of variables in the equation, in this study the R^2 adjusted for the number of variables was used.

Two other criteria used here involved the distribution of the predicted salaries and the distribution of the residuals. These distributions were examined by visual inspection of stem-and-leaf displays, histograms, normal probability plots, descriptive statistics, and various scatter plots against different independent variables, the dependent variable, and against each other. A final criterion used was the standard deviation of the residuals. The criteria used here are a subset of the statistical methodology known as regression diagnostics. In order to keep this paper at a manageable length, copies of the above graphics and descriptive statistics have not been included in the paper. Copies are available from the author.

The variables that were found to best predict males' salaries, when Rank was not used as one of the possible independent variables, are reported in Table 2 in terms of their order of entry. The adjusted R^2's and the standard deviations of the residuals (called S_e) as each variable was added are also given in Table 2. The results of the analyses when Rank was used as one of the possible independent variables are given in Table 3.

INSERT TABLES 2 AND 3 HERE

Comparison of the Regression Equations for the Male Faculty Members

It should be noticed that the independent variables used in the models where Rank was and was not allowed as a predictor are the same, except that Rank replaces Highest Degree when one moves from the model that did not allow Rank as a predictor to the one that did. Further, the equation that did not allow Rank as one of the predictors achieved a multiple R^2 of only 63.7%, while the model that allowed Rank as one the predictors achieved a multiple R^2 of 81.6%. Also, the standard deviation of the residuals was larger for the model that did not allow Rank as one of the predictors ($4075) than for the model that did ($2897).

Application of Regression Equations to Female Faculty Members

When the regression equation, that was based on the male faculty data, without Rank as a predictor was applied to the female faculty data, it was found that the mean residual for the females was -$3113. That is, on the average, female faculty members were underpaid $3113 as compared to comparable male faculty. These analyses, as well as all remaining analyses involving female faculty, are based on the data for the 78 female probationary or tenured faculty members. The median for the residuals was -$3637 for females and +$311 for males. The standard deviations of the residuals for females was $4897 and $4075 for the males. In addition, various graphical and

statistical criteria were used to check on the validity of the assumptions underlying the regression analyses.

The exact number of and percentages of male and female faculty in the various colleges whose predicted salaries were one or more standard deviations below their actual salaries was then computed (that is, a standardized residual of less than -1.0). The standard deviation of $4075 for the males was used when computing the standardized residuals for both males and females. These numbers and percentages are given in Table 4 (for males) and Table 5 (for females). Tables 4 and 5 also include the numbers and percentages when the model using Rank as one of the predictors is used.

It is realized that Tables 4 and 5 are not easy to read. Using the row of Table 4 that is labelled Lib. Arts, it was found that 17 (or 34%) of the males in the College of Liberal Arts had a standardized residual of less than -1.0 under one or both of the models (see the fourth column). In particular, 11 had a standardized residual of less than -1.0 under the model that did not include Rank (see the second column) and 9 had a standardized residual of less than -1.0 under the model that did include Rank (see the third column). But, only 3 of these individuals had a standardized residual of less than -1.0 under both models (see the first column).

The inequities found using the regression equation with Rank as one of the predictors were not as severe as the inequities found using the regression equation that did not allow Rank as a

predictor. The mean residual for females, as compared to males, was -$1711. The median residual was -$1494 for females and +$79 for males. The standard deviation was $4147 for females and $2897 for males.

As can be seen in Tables 4 and 5, different faculty (both male and female) are identified as having standardized residuals of less than -1.0 under the two models (i.e., the one using Rank and the one not using Rank). Further, the sizes of individuals' residuals were in some cases quite different under the two equations. The individual residuals are not included here in order to comply with Minnesota's privacy laws. Hence, many faculty, who were identified as having salary inequities under the model using Rank, would not have been identified if only a model not using Rank as one of the predictors had been used. On the whole, however, the model using Rank as one of the predictors underestimated the inequity in salaries between male and female faculty as compared to the model that did not use Rank as a predictor.

It very clear that under both models, the residuals for the females are lower than those for the males. From comparing Tables 4 and 5, it can be seen that this inequity occurs for all Colleges and occurs under both models. That is, for every entry in Table 5 (except for the College of Business when the model that included Rank is used), the percentage of females in that category found to have low residuals is greater than or equal to the percentage of males in that category found to have low

residuals. In most cases, the percentages of females found to have low residuals is much greater than the percentage of males. For example, 56% of the females faculty members in the College of Liberal Arts were found to have a standardized residual of less than -1.0, while 14% of the male faculty members in that College were found to have a standardized residual of less than -1.0 under the model that used Rank as one of the predictors. Tables constructed using a cut-off of 1 1/2 or 2 standard deviations below the mean showed similar inequities.

Limitations of This Study

1. The final study did not include Fixed-Term and Non-Tenure Track faculty.

2. The final study did not examine differences between Caucasian and non-Caucasian faculty members.

3. Throughout both the preliminary and final studies, faculty members from different units were combined into College units that seemed logical to the author, Women's Issue Committee, and the Vice President of Academic Affairs. The variable College was then used as one of the independent variables in the analyses performed as part of these studies. The estimates of inequality reached in this study will not be the same as in a study where the departments were grouped differently. From visual inspection of various plots and descriptive statistics, the estimates of

inequality would have been, on the whole, fairly close if a slightly different grouping had been used.

References

Gray, M. W. (1990). Achieving pay equity on campus. Washington, D.C.: American Association of University Professors.

Scott, E. L. (1977). Higher education salary evaluation kit. Washington D. C.: American Association of University Professors.

Table 1

Percentages of Faculty in Various Types of Positions That Have a Standardized Residual of Less Than -1.0 (Broken Down by Gender)

Gender and Position Type	Total Number of People	Number with Residual of Less Than -1 S.D.	Percentage
Male--Fixed Term or Non-Tenure Track	38	12	31.58%
Female--Fixed Term or Non-Tenure Track	37	19	51.35%
Male--Tenure Track or Tenured	176	14	7.95%
Female--Tenure Track or Tenured	78	18	23.08%

Note: The percentages in the last column of this table are the percent of those in each row of the table that have a standardized residual of less than -1.

Table 2

Results of Regression Analyses
Without Using Rank as a Predictor
(Probationary and Tenured Males Only)

Variable Added	Total R^2	S_e
Years in State Univ. System	32.6%	$5551
Eligible or Not for Market Bonus	48.6%	$4846
Highest Degree	55.1%	$4529
College	59.7%	$4294
Age	63.7%	$4075

Table 3

Results of Regression Analyses
Using Rank as a Predictor
(Probationary and Tenured Males Only)

Variable Added	Total R^2	S_e
Years in State Univ. System	32.6%	$5551
Rank	73.5%	$3478
Eligible or Not for Market Bonus	78.8%	$3112
College	80.9%	$2958
Age	81.6%	$2897

Table 4
Number and Percentages of Probationary and Tenured Males with Low Standardized Residuals Using a Cut-off of -1.0 (Broken Down by College)

COLLEGE	< -1.0 UNDER BOTH MODELS	< -1.0 UNDER THE NO RANK MODEL	< -1.0 UNDER THE RANK MODEL	NUMBER OF LOW RESID.	TOTAL NUMBER OF MALES
BUSIN.	2 (6%)	5 (15%)	5 (15%)	8 (24%)	33
EDUCA.	2 (7%)	5 (19%)	4 (15%)	7 (26%)	27
LIB. ARTS	3 (4%)	11 (18%)	9 (14%)	17 (34%)	63
NURSING/ SCIENCE	1 (2%)	6 (13%)	5 (11%)	10 (21%)	47
OTHER	1 (17%)	1 (17%)	2 (33%)	2 (33%)	6
TOTALS	9 (5%)	28 (16%)	25 (14%)	44 (25%)	176

Table 5
Number and Percentages of Probationary and Tenured Females with Low Standardized Residuals Using a Cut-off of -1.0 (Broken Down by College)

COLLEGE	< -1.0 UNDER BOTH MODELS	< -1.0 UNDER THE NO RANK MODEL	< -1.0 UNDER THE RANK MODEL	NUMBER OF LOW RESID.	TOTAL NUMBER OF FEMALES
BUSIN.	1 (11%)	3 (33%)	1 (11%)	3 (33%)	9
EDUCA.	1 (7%)	4 (27%)	4 (27%)	7 (47%)	15
LIB. ARTS	4 (25%)	8 (50%)	9 (56%)	13 (81%)	16
NURSING/ SCIENCE	8 (30%)	17 (57%)	10 (33%)	19 (60%)	30
OTHER	3 (38%)	4 (50%)	4 (50%)	5 (63%)	8
TOTALS	17 (23%)	36 (46%)	28 (36%)	47 (59%)	78